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# MACHINE AND OPERATOR VARIATIONS ON THE PRESSLEY COTTON FIBER STRENGTH TESTER

By Jacob V. Shepherd, Junior Cotton Technologist 1/

## INTRODUCTION

To meet the need for a more rapid and simpler method of obtaining the tensile strength of cotton fibers, the Pressley Cotton Fiber Strength Tester was developed 2/. With this device, small bundles or ribbons of fibers, sheared to a uniform length, are inserted in the tester, and a load is applied to each by means of a rolling weight. Readings are taken of the load required to break the ribbons, and the quotient of the breaking load in pounds and the weight of the ribbon in milligrams is considered as the strength index for a particular cotton.

The Chandler round-bundle method of determining strength has been used in the cotton testing laboratories of the United States Department of Agriculture since the development of the method in these laboratories a number of years ago 3/. Comparative tests of the Pressley machine in 1940 showed a very close agreement between the two methods, and indicated that tests could be made with the Pressley tester about 6 to 8 times as rapidly as with the Chandler method. As a result of these tests, the Pressley method was adopted as an alternate test for fiber strength in Cotton Fiber Testing Service 4/.

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1/ Acknowledgment is made to Walter E. Chapman, Jr., Zula G. Caperton, and Marjorie N. Terry for assistance in making the strength tests involved in this study.

2/ Developed by Professor E. H. Pressley, University of Arizona.

3/ Richardson, Howard H., Bailey, T. L. W., Jr., and Conrad, Carl M., Methods for the Measurement of Certain Character Properties of Raw Cotton, U.S.D.A. Tech. Bul. No. 545.

4/ U.S.D.A., Agricultural Marketing Administration. Promulgation of Regulations of the Secretary of Agriculture Governing Fiber and Spinning Tests under the Act of April 7, 1941 (Promulgated November 2, 1941).

Because a large volume of data had been accumulated with the round-bundle method which expresses fiber strength in terms of thousands of pounds per square inch of material, it was thought desirable to convert the Pressley indexes to round-bundle strengths, if practicable. This was found to be entirely feasible, and a conversion equation was developed which is now in routine use 5/. A high correlation has been found between Pressley index and Chandler strength, and, therefore, the conversion equation makes it possible to express fiber strength, as determined by the Pressley tester, in pounds per square inch.

As more Pressley machines have been put into service and wider experience obtained with them in the laboratories, some variation in results has been found to exist between operators in addition to some discrepancies between machines. It was the purpose of this study, therefore, to determine in a systematic way the extent of the differences between operators and between machines that would be statistically significant. This study also provided data for a further consideration of the relationship between Pressley index and Chandler round-bundle strength.

## TEST PROCEDURE

Eight machines, designated A, B, C, D, E, F, G, and H, were used in the study made under standard atmospheric conditions in the Cotton Testing Laboratory at Stoneville, Miss., in July 1942. Twenty-four cottons used in these tests were selected from the 1935-37 regional variety study and covered a wide range in fiber strength, staple length, and other physical properties. On each of these cottons, 10 breaks were made by each of four operators on each of the eight machines, giving a total of 7,680 breaks. The breaking order was set up in a randomized block with each operator making 10 breaks on each cotton on each of the machines in the order shown in table 8 in the appendix. Any variation not accounted for by operators, machines, or cottons can be considered attributable to experimental error.

One clamp vise for holding the jaws was used for each pair of machines in this study, and a fifth vise was moved from machine to machine in case two operators wanted to use the same vise at the same time. This extra vise was used several times and enabled the operators to run the machines in the planned order with very little loss of time. Only four sets of tools (tweezers, knife, and wrench) were used in operating the eight machines.

In preliminary operations made with the various machines, it was found that the leveling of the machines both crosswise and lengthwise was not enough to insure smooth and unhampered movement of the rolling weight. Consequently the following technique was developed: The machines were leveled crosswise and set so that the beam containing the tracks was on a 1-1/2° incline with loaded clamps placed in the breaking position in the tester. After removing the clamps, the friction bars were set so that the beam would have a 3° incline when the rolling weight or poise was at 15 pounds on the beam. These settings were checked every day to make sure they had not changed during the operation of the machine. A

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5/ United States Agricultural Marketing Service. Cotton Fiber Testing Service. 1941. (Mimeographed)

small spring was placed on the weight-holding pins of the six newer machines (A, B, C, D, E, and G) in order to enable the operator to start the car by barely raising the trip lever. These springs did not work satisfactorily on the two older machines (F and H). In this connection, each machine was timed with a stop watch and oscillograph after thin paper had been inserted in the clamps so that the weight would run the entire length of the track without breaking the paper. The springs did not increase the speed of the weight, as will be observed from the following table.

Table 1. - Time required for track travel of weight of the machines tested as measured by two methods

| Machine | Car speed as measured by-- | |
|---|---|---|
| | Oscillograph | Stop watch 1/ |
| | Seconds | Seconds |
| A | 2.01 | 1.84 |
| B | 1.98 | 1.65 |
| C | 2.00 | 1.86 |
| D | 1.98 | 1.76 |
| E | 1.96 | 1.75 |
| F | 1.36 | 1.46 |
| G | 1.78 | 1.52 |
| H | 1.45 | 1.49 |

1/ Average time of four operators



In addition to the care exercised in setting up the machines for testing, the metal parts of the clamps which came in contact with the hands were given a light coat of grease every week to prevent rust. The friction bars were also wiped off every day, and accumulated lint or fly was blown from the beam tracks.

In the following paragraphs, the procedure for making the tests is described in detail in order that other workers may be able to compare every phase of their technique with that used in the tests reported here. Very slight differences in manipulating the fibers may influence the results, and only by carefully considering even the smallest details can the worker hope to eliminate important variables.

The 24 cottons employed in the tests were sampled by taking 32 pinches throughout each sample. These pinches were each pulled out by hand into "slivers" or strands and then combined. Each of the 24 slivers was broken into 20 pieces. Each group of 5 pieces was used to make 5 tufts in the following manner: Pulls were made from each piece and combined, then combed several times with a coarse comb to straighten out the fibers and to make one tuft. This process was repeated 4 times to make the 5 tufts from 5 pieces. Each of the 4 operators had a set of 20 tufts (5 tufts from the 4 sliver makers) on all of the 24 cottons.

In making the break, one pull was made from the tuft with the thumb and forefinger of the right hand. The fibers were then grasped in the same manner with the left hand about one-fourth of the distance between the ends, and drawn from left to right through the comb attached to the vise. The bulk of the fibers came about midway, vertically, in the teeth of the comb, and the ribbon at this stage was held as nearly as possible to a width of 3/8 inch. The next pull was made by holding the fibers the same way, but in the right hand with the ribbon narrowed to 1/4 inch, and pulled horizontally through the comb from right to left. Marks were placed on the jaws of the vise to aid in keeping the ribbons 1/4 inch in width. It was found by preliminary tests that a ribbon 1/4-inch wide gave the best results (Appendix table 9). Efforts were made to keep the ribbons uniform in size in the study. Even so, beam readings indicating the breaks of the ribbon varied from 9 to 21. Most of the range, however, was associated with the range in the strengths of the cottons tested.

By holding the ribbon with the thumb and forefinger of each hand, the operator placed it in the clamp about in the center of the leather facings, with as much of the ribbon extending through the clamps on one side as on the other. With the forefinger of the operator's left hand the lever for gripping the fibers was put down and then held with the left thumb while the left forefinger flipped the top part of the clamps into position for tightening. Enough tension was applied to the ribbon with the right thumb to straighten the fibers. The forefinger of the left hand put enough pressure on the tops of the equalizers in the clamps to hold the fibers in place. The right hand was used, first to tighten the right screw, then the left one. Only enough pressure was used to cause all the fibers to break. Next, the clamps were removed from the vise and the protruding ends of the ribbon were sheared off with the tool provided for that purpose. Then the clamps were placed in the machine and the rolling weight was released. When the weight stopped, the reading in pounds was recorded. Before the weight was moved back to the starting position, the beam reading was checked. The clamps were again placed in the vise and the broken ribbon was removed, care being used to remove all the fibers from the clamps. The broken pieces of ribbon or breaks were placed in black papers, which were folded and put in racks from back to front in the order in which the breaks occurred. The rack was turned around so the breaks could be weighed from front to back or in the order in which they occurred. The breaks were weighed individually to the nearest one-hundredth milligram, and every possible precaution was taken to prevent loss of fibers in the process. The black paper was placed directly under the balance hook to receive any fibers that might drop from the hook of the balance so that any lost fibers might be replaced on the hook for weighing. Care was exercised in unfolding the papers in an effort to prevent the fibers from clinging to the paper. The four machine operators weighed their own breaks on two balances. Check tests were made to keep the weighing as accurate as possible.

As further insurance of reducing variations in technique to a minimu, check tests were made periodically by all four operators on a laboratory check sample (Appendix table 10).

## TEST RESULTS AND THEIR APPLICATION IN TESTING OPERATIONS

### Test Results

After the 4 operators completed the making of 10 breaks on each of the 24 cottons with each of the 8 machines in the order of breaking listed in Appendix table 8, average Pressley indexes were calculated from the data representing each of the 10 breaks made by each operator. Pressley indexes were computed by dividing the beam reading by the weight of the ribbon, and averaging the 10 quotients thus obtained to give an average index for each sample for each machine. These averages are given in tables 2 to 6. It will be noted that the operators' average index on all tests ranges from 7.24 to 7.58, which range, when converted to Chandler strength, would be about 3,000 pounds per square inch.

Stoneville operators B and C, who had over 1 year of experience in testing work on machines C and E, gave identical average indexes. Operators A and D, who had only a few days of experience before the study was put under way, showed more divergent results. Further analyses of the different operators' schedules of testing and results showed that operator D's higher indexes as compared with those of operators B and C were associated with a greater number of tests being made during early morning than during late afternoon. This so far unexplainable difference in morning and afternoon results was also experienced by the designer of the machine during its early development.

The average indexes of all operators showed for 7 machines a range similar to that found for the different operators, with machine A giving a materially lower average strength index than these 7 machines in spite of the fact that extra care was exercised by all operators in applying a uniform technique with all machines. More ragged breaks were in evidence with machine A than with the other machines in this test, and, therefore, the lower breaks with this machine as compared with the others are explainable. Efforts were made to apply light pressure in tightening the clamp screws as recommended by the manufacturer; and before the conclusion of the test, it became apparent that greater pressure should have been applied in tightening the clamps of machine A. Subsequent use of this machine gave results comparable to those obtained with the other machines when the precautions in testing procedure which the test results revealed to be basic to obtaining consistent results were carefully observed.

A portion of the difference between machines may be traceable to the time of day when most of the tests were made, as was the case in determining some of the reasons for the differences indicated between operators. All the machines having an average index for all cottons and all operators in excess of 7.28 were used to a greater extent in the tests in the morning than in those in the afternoon. The machines showing average indexes of 7.28 and lower were employed to a lesser extent in tests during the morning than in those in the afternoon.

In analyzing the results, "F" values were computed as shown in table 7. It was found that there was a significant difference between means for operators as well as between means for machines, even though the differences indicated were small on the average in most cases. A study of the "F" value for interaction between machines and operators indicated that there is a slight difference in results obtained on the same machine by different operators.

Table 2. - Average Pressley strength indexes for operator A on the different cottons and machines employed in the tests

| Cotton sample number | Machines | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | All |
| 1 | 9.22 | 8.63 | 9.00 | 9.11 | 8.60 | 8.91 | 8.95 | 8.96 | 8.92 |
| 2 | 7.74 | 7.70 | 8.10 | 8.39 | 7.81 | 8.30 | 7.99 | 8.07 | 8.01 |
| 3 | 6.22 | 6.22 | 6.37 | 6.23 | 6.15 | 6.02 | 6.44 | 6.14 | 6.22 |
| 4 | 5.71 | 5.70 | 5.89 | 6.24 | 5.46 | 5.83 | 5.86 | 5.97 | 5.83 |
| 5 | 6.42 | 6.33 | 6.44 | 6.82 | 6.32 | 6.46 | 6.70 | 6.58 | 6.51 |
| 6 | 6.14 | 6.01 | 6.01 | 6.81 | 6.08 | 6.43 | 6.60 | 6.52 | 6.32 |
| 7 | 6.69 | 6.89 | 6.68 | 6.63 | 6.35 | 6.86 | 7.03 | 6.24 | 6.67 |
| 8 | 7.16 | 7.15 | 7.22 | 7.44 | 7.23 | 7.71 | 7.25 | 7.34 | 7.31 |
| 9 | 7.33 | 6.89 | 7.24 | 7.35 | 7.23 | 7.67 | 7.81 | 7.27 | 7.35 |
| 10 | 6.05 | 6.49 | 6.53 | 6.42 | 6.32 | 6.32 | 6.35 | 6.35 | 6.35 |
| 11 | 6.23 | 6.58 | 6.82 | 6.32 | 6.44 | 6.68 | 6.54 | 6.19 | 6.48 |
| 12 | 6.38 | 7.78 | 7.42 | 7.52 | 6.99 | 7.55 | 7.20 | 7.75 | 7.32 |
| 13 | 6.14 | 6.47 | 6.38 | 6.82 | 6.59 | 6.19 | 6.68 | 6.90 | 6.52 |
| 14 | 7.19 | 7.63 | 7.93 | 8.54 | 7.92 | 8.25 | 8.58 | 8.58 | 8.08 |
| 15 | 7.29 | 7.52 | 7.08 | 7.86 | 7.65 | 7.26 | 7.94 | 7.33 | 7.49 |
| 16 | 6.90 | 7.37 | 7.71 | 7.77 | 7.74 | 7.55 | 7.71 | 7.80 | 7.57 |
| 17 | 7.20 | 8.20 | 8.81 | 8.38 | 8.60 | 8.09 | 9.12 | 9.13 | 8.44 |
| 18 | 6.88 | 7.56 | 7.51 | 7.34 | 7.47 | 7.25 | 7.86 | 7.87 | 7.47 |
| 19 | 7.50 | 8.46 | 8.56 | 8.62 | 9.09 | 8.70 | 8.35 | 8.30 | 8.45 |
| 20 | 7.46 | 8.78 | 8.68 | 8.59 | 9.24 | 9.35 | 8.70 | 8.65 | 8.68 |
| 21 | 7.08 | 8.38 | 8.84 | 8.13 | 9.23 | 8.61 | 8.48 | 8.21 | 8.37 |
| 22 | 7.03 | 7.44 | 8.06 | 8.21 | 7.97 | 8.09 | 7.89 | 7.28 | 7.75 |
| 23 | 6.53 | 6.45 | 6.75 | 7.16 | 7.22 | 7.26 | 7.05 | 6.61 | 6.88 |
| 24 | 6.81 | 6.50 | 7.02 | 7.44 | 6.68 | 7.68 | 7.14 | 7.10 | 7.05 |
| All | 6.89 | 7.21 | 7.38 | 7.51 | 7.35 | 7.46 | 7.51 | 7.38 | 7.34 |

Table 3. - Average Pressley strength indexes for operator B on the different cottons and machines employed in the tests

| Cotton sample number | Machines | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | All |
| 1 | 7.65 | 8.45 | 9.14 | 9.12 | 9.08 | 9.42 | 8.64 | 8.24 | 8.72 |
| 2 | 7.18 | 7.19 | 7.91 | 8.09 | 8.00 | 8.13 | 7.86 | 7.00 | 7.67 |
| 3 | 5.45 | 6.04 | 5.98 | 6.27 | 5.98 | 6.33 | 5.77 | 6.00 | 5.98 |
| 4 | 5.26 | 5.38 | 5.77 | 5.84 | 5.63 | 5.80 | 5.73 | 5.65 | 5.63 |
| 5 | 5.93 | 5.95 | 6.31 | 6.75 | 6.08 | 6.47 | 6.21 | 6.56 | 6.28 |
| 6 | 6.06 | 5.84 | 6.63 | 6.36 | 6.22 | 6.42 | 6.13 | 5.84 | 6.19 |
| 7 | 6.28 | 6.63 | 6.61 | 6.54 | 6.38 | 6.82 | 6.64 | 6.67 | 6.57 |
| 8 | 6.52 | 7.08 | 7.01 | 7.19 | 7.31 | 7.12 | 7.37 | 7.09 | 7.09 |
| 9 | 6.39 | 7.11 | 7.26 | 7.40 | 7.46 | 7.20 | 7.24 | 7.39 | 7.18 |
| 10 | 5.91 | 5.78 | 6.23 | 6.54 | 6.48 | 6.18 | 6.39 | 5.98 | 6.19 |
| 11 | 6.35 | 6.15 | 6.27 | 6.44 | 6.44 | 6.36 | 6.24 | 6.52 | 6.35 |
| 12 | 6.88 | 6.69 | 7.58 | 7.44 | 7.31 | 7.46 | 7.72 | 7.06 | 7.27 |
| 13 | 5.58 | 6.16 | 6.65 | 6.63 | 6.07 | 6.94 | 7.02 | 6.53 | 6.45 |
| 14 | 7.48 | 7.56 | 8.37 | 8.28 | 7.65 | 8.24 | 8.50 | 8.15 | 8.03 |
| 15 | 6.89 | 6.88 | 7.51 | 7.46 | 6.46 | 7.79 | 7.54 | 7.32 | 7.23 |
| 16 | 7.09 | 6.75 | 7.88 | 7.54 | 7.50 | 7.50 | 7.56 | 7.50 | 7.42 |
| 17 | 7.78 | 8.44 | 8.82 | 8.19 | 7.99 | 8.46 | 9.06 | 8.27 | 8.38 |
| 18 | 6.69 | 7.20 | 7.95 | 7.32 | 7.33 | 7.42 | 7.86 | 6.97 | 7.34 |
| 19 | 8.41 | 8.72 | 7.80 | 8.75 | 8.90 | 8.98 | 8.52 | 8.45 | 8.57 |
| 20 | 8.60 | 8.29 | 8.54 | 8.96 | 9.06 | 9.62 | 9.20 | 8.27 | 8.82 |
| 21 | 7.55 | 8.37 | 8.41 | 8.69 | 8.39 | 8.80 | 8.53 | 8.40 | 8.39 |
| 22 | 8.00 | 7.78 | 7.45 | 7.90 | 7.94 | 8.45 | 8.04 | 8.02 | 7.95 |
| 23 | 6.68 | 6.98 | 6.82 | 7.35 | 7.24 | 7.51 | 7.14 | 7.22 | 7.12 |
| 24 | 7.27 | 6.27 | 7.04 | 7.45 | 6.99 | 7.31 | 6.89 | 6.94 | 7.02 |
| All | 6.83 | 6.99 | 7.33 | 7.44 | 7.25 | 7.53 | 7.41 | 7.17 | 7.24 |

Table 4. - Average Pressley strength indexes for operator C on the different cottons and machines employed in the tests

| Cotton sample number | Machines | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | All |
| 1 | 8.24 | 7.93 | 8.81 | 8.98 | 8.53 | 9.21 | 8.55 | 8.28 | 8.57 |
| 2 | 7.14 | 7.23 | 8.06 | 7.54 | 8.09 | 8.28 | 7.54 | 7.44 | 7.66 |
| 3 | 6.03 | 6.10 | 6.15 | 6.10 | 5.78 | 6.18 | 5.93 | 6.07 | 6.04 |
| 4 | 5.23 | 5.54 | 5.73 | 6.13 | 5.56 | 5.56 | 5.67 | 5.60 | 5.63 |
| 5 | 6.12 | 6.36 | 6.22 | 6.49 | 6.31 | 6.65 | 6.22 | 5.64 | 6.25 |
| 6 | 6.21 | 6.18 | 6.05 | 6.37 | 6.43 | 6.36 | 5.98 | 5.91 | 6.19 |
| 7 | 6.13 | 6.50 | 6.43 | 6.87 | 6.53 | 6.48 | 6.26 | 6.63 | 6.48 |
| 8 | 6.71 | 6.94 | 6.80 | 7.57 | 7.59 | 6.70 | 7.07 | 7.16 | 7.07 |
| 9 | 6.53 | 7.02 | 6.88 | 7.52 | 7.44 | 6.57 | 7.14 | 6.62 | 6.96 |
| 10 | 5.93 | 6.29 | 6.27 | 6.39 | 6.50 | 6.28 | 6.32 | 6.32 | 6.29 |
| 11 | 5.97 | 6.40 | 6.37 | 6.58 | 6.54 | 6.39 | 6.42 | 6.55 | 6.40 |
| 12 | 7.08 | 7.09 | 7.11 | 7.36 | 7.33 | 6.97 | 7.36 | 7.65 | 7.24 |
| 13 | 6.25 | 6.40 | 6.58 | 6.49 | 6.57 | 6.86 | 6.97 | 6.30 | 6.55 |
| 14 | 7.66 | 7.95 | 8.32 | 7.62 | 8.49 | 8.87 | 8.37 | 7.68 | 8.12 |
| 15 | 6.95 | 7.02 | 7.74 | 7.38 | 7.16 | 7.73 | 7.60 | 6.85 | 7.30 |
| 16 | 7.07 | 7.32 | 7.91 | 7.45 | 7.18 | 7.57 | 7.44 | 7.20 | 7.39 |
| 17 | 7.46 | 8.00 | 8.88 | 8.31 | 8.73 | 8.86 | 8.71 | 7.96 | 8.36 |
| 18 | 6.58 | 7.04 | 7.84 | 7.76 | 7.59 | 7.70 | 7.35 | 7.03 | 7.36 |
| 19 | 9.03 | 8.84 | 8.64 | 8.82 | 9.34 | 8.74 | 8.76 | 8.35 | 8.82 |
| 20 | 8.80 | 8.52 | 8.76 | 8.74 | 8.93 | 9.12 | 8.80 | 8.34 | 8.75 |
| 21 | 8.41 | 8.16 | 8.58 | 8.70 | 8.48 | 8.62 | 8.30 | 8.21 | 8.43 |
| 22 | 7.96 | 7.81 | 8.13 | 7.78 | 8.06 | 8.64 | 8.12 | 7.54 | 8.00 |
| 23 | 6.79 | 6.63 | 7.00 | 7.25 | 6.56 | 7.22 | 7.18 | 6.75 | 6.92 |
| 24 | 6.49 | 6.84 | 6.97 | 7.20 | 7.10 | 7.24 | 7.19 | 7.02 | 7.01 |
| All | 6.95 | 7.09 | 7.34 | 7.39 | 7.37 | 7.45 | 7.30 | 7.00 | 7.24 |

Table 5. - Average Pressley strength indexes for operator D on the different cottons and machines employed in the tests

| Cotton sample number | Machines | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | All |
| 1 | 8.61 | 9.84 | 9.26 | 9.17 | 9.24 | 9.06 | 9.36 | 9.68 | 9.28 |
| 2 | 7.78 | 7.88 | 7.80 | 8.11 | 8.12 | 8.24 | 8.48 | 8.06 | 8.06 |
| 3 | 5.99 | 6.16 | 6.24 | 6.20 | 6.06 | 6.41 | 6.27 | 6.35 | 6.21 |
| 4 | 6.09 | 5.74 | 5.97 | 6.01 | 5.60 | 5.76 | 6.03 | 5.89 | 5.89 |
| 5 | 6.16 | 6.51 | 6.60 | 6.57 | 6.22 | 6.26 | 6.42 | 6.62 | 6.42 |
| 6 | 6.21 | 6.21 | 6.02 | 6.75 | 6.14 | 6.29 | 6.38 | 6.55 | 6.32 |
| 7 | 6.51 | 6.88 | 6.72 | 6.84 | 6.63 | 6.74 | 6.59 | 6.60 | 6.69 |
| 8 | 7.20 | 7.46 | 7.49 | 7.43 | 7.50 | 7.39 | 7.59 | 7.24 | 7.41 |
| 9 | 7.05 | 7.36 | 7.30 | 7.46 | 7.49 | 7.74 | 7.54 | 7.78 | 7.46 |
| 10 | 6.47 | 6.56 | 6.54 | 6.47 | 6.37 | 6.43 | 6.58 | 6.10 | 6.44 |
| 11 | 6.38 | 6.95 | 6.57 | 6.95 | 6.53 | 6.73 | 6.58 | 6.22 | 6.61 |
| 12 | 7.04 | 7.16 | 7.39 | 7.52 | 7.60 | 7.56 | 7.64 | 7.17 | 7.38 |
| 13 | 6.86 | 6.90 | 6.77 | 7.14 | 6.77 | 6.88 | 6.77 | 6.84 | 6.87 |
| 14 | 8.52 | 8.44 | 8.71 | 8.40 | 8.61 | 8.67 | 8.55 | 8.63 | 8.57 |
| 15 | 8.00 | 7.81 | 7.81 | 7.92 | 7.54 | 7.91 | 7.94 | 8.11 | 7.88 |
| 16 | 7.95 | 7.53 | 7.78 | 7.95 | 7.62 | 7.77 | 7.80 | 7.59 | 7.75 |
| 17 | 9.08 | 8.70 | 8.76 | 9.11 | 8.56 | 9.16 | 9.06 | 8.99 | 8.93 |
| 18 | 7.58 | 7.66 | 7.60 | 7.86 | 7.34 | 7.52 | 8.03 | 7.69 | 7.66 |
| 19 | 8.42 | 8.83 | 9.16 | 8.77 | 8.89 | 9.54 | 9.11 | 8.50 | 8.90 |
| 20 | 8.75 | 9.16 | 9.84 | 9.08 | 8.69 | 9.25 | 9.45 | 8.76 | 9.12 |
| 21 | 8.77 | 8.71 | 9.20 | 8.95 | 8.62 | 9.22 | 8.78 | 8.83 | 8.88 |
| 22 | 8.47 | 8.09 | 8.72 | 8.30 | 8.35 | 8.60 | 8.62 | 8.08 | 8.40 |
| 23 | 6.96 | 7.57 | 7.50 | 7.31 | 7.04 | 7.44 | 7.39 | 7.38 | 7.32 |
| 24 | 6.86 | 7.43 | 7.58 | 7.33 | 7.06 | 7.66 | 7.84 | 7.28 | 7.38 |
| All | 7.40 | 7.56 | 7.64 | 7.65 | 7.44 | 7.68 | 7.70 | 7.54 | 7.58 |

Table 6. - Average Pressley strength indexes for all operators on the different cottons and machines employed in the tests

| Cotton sample number | Machines | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | All |
| 1 | 8.43 | 8.71 | 9.05 | 9.10 | 8.86 | 9.15 | 8.88 | 8.79 | 8.87 |
| 2 | 7.46 | 7.50 | 7.97 | 8.03 | 8.00 | 8.24 | 7.97 | 7.64 | 7.85 |
| 3 | 5.92 | 6.13 | 6.18 | 6.20 | 5.99 | 6.24 | 6.10 | 6.14 | 6.11 |
| 4 | 5.57 | 5.59 | 5.84 | 6.06 | 5.56 | 5.74 | 5.82 | 5.78 | 5.74 |
| 5 | 6.16 | 6.29 | 6.39 | 6.66 | 6.23 | 6.46 | 6.39 | 6.35 | 6.37 |
| 6 | 6.16 | 6.06 | 6.18 | 6.57 | 6.22 | 6.38 | 6.27 | 6.20 | 6.25 |
| 7 | 6.40 | 6.72 | 6.61 | 6.72 | 6.47 | 6.72 | 6.63 | 6.53 | 6.60 |
| 8 | 6.90 | 7.16 | 7.13 | 7.41 | 7.41 | 7.23 | 7.32 | 7.21 | 7.22 |
| 9 | 6.82 | 7.10 | 7.17 | 7.43 | 7.40 | 7.30 | 7.43 | 7.26 | 7.24 |
| 10 | 6.09 | 6.28 | 6.39 | 6.46 | 6.42 | 6.30 | 6.41 | 6.19 | 6.32 |
| 11 | 6.23 | 6.52 | 6.51 | 6.57 | 6.49 | 6.54 | 6.44 | 6.37 | 6.46 |
| 12 | 6.84 | 7.18 | 7.38 | 7.46 | 7.31 | 7.38 | 7.48 | 7.41 | 7.30 |
| 13 | 6.21 | 6.48 | 6.60 | 6.77 | 6.50 | 6.72 | 6.86 | 6.64 | 6.60 |
| 14 | 7.71 | 7.90 | 8.33 | 8.21 | 8.17 | 8.51 | 8.50 | 8.26 | 8.20 |
| 15 | 7.28 | 7.31 | 7.54 | 7.66 | 7.20 | 7.67 | 7.76 | 7.40 | 7.48 |
| 16 | 7.25 | 7.24 | 7.82 | 7.68 | 7.51 | 7.60 | 7.63 | 7.52 | 7.53 |
| 17 | 7.88 | 8.34 | 8.82 | 8.50 | 8.47 | 8.64 | 8.99 | 8.59 | 8.53 |
| 18 | 6.93 | 7.36 | 7.72 | 7.57 | 7.43 | 7.47 | 7.78 | 7.39 | 7.46 |
| 19 | 8.34 | 8.71 | 8.54 | 8.74 | 9.06 | 8.99 | 8.68 | 8.40 | 8.68 |
| 20 | 8.40 | 8.69 | 8.96 | 8.84 | 8.98 | 9.34 | 9.04 | 8.50 | 8.84 |
| 21 | 7.95 | 8.40 | 8.76 | 8.62 | 8.68 | 8.81 | 8.52 | 8.41 | 8.52 |
| 22 | 7.86 | 7.78 | 8.09 | 8.05 | 8.08 | 8.44 | 8.17 | 7.73 | 8.03 |
| 23 | 6.74 | 6.91 | 7.02 | 7.27 | 7.02 | 7.36 | 7.19 | 6.99 | 7.06 |
| 24 | 6.86 | 6.76 | 7.15 | 7.36 | 6.96 | 7.47 | 7.27 | 7.08 | 7.11 |
| All | 7.02 | 7.21 | 7.42 | 7.50 | 7.35 | 7.53 | 7.48 | 7.28 | 7.35 |

Table 7. - Analysis of variance for entire test embracing cotton varieties, Pressley machines, and operators

| Source of variation | Degrees of freedom | Sum of squares | Mean square or variance | F value | | |
|---|---|---|---|---|---|---|
| | | | | Found | Required 5% | Required 1% |
| Varieties | 23 | 639.82 | 27.82 | 397.43 | 1.54 | 1.83 |
| Machines | 7 | 20.10 | 2.87 | 41.00 | 1.96 | 2.55 |
| Operators | 3 | 14.39 | 4.80 | 68.57 | 2.62 | 3.82 |
| Interactions: | | | | | | |
| Varieties x machines | 161 | 12.01 | 0.07 | 1.00 | 1.06 | 1.08 |
| Varieties x operators | 69 | 7.24 | 0.10 | 1.43 | 1.06 | 1.08 |
| Machines x operators | 21 | 4.37 | 0.21 | 3.00 | 1.54 | 1.83 |
| Error | 483 | 33.23 | 0.07 | | | |
| Total | 767 | 731.16 | | | | |

## Applying Test Results

In the light of the test results and observations made during the tests, it is apparent that close supervision and checking of operators as well as periodic machine comparisons are essential to consistent results. To obtain such results requires frequent testing of a check sample by different operators on the same machine, and by each operator on different machines, as well as a scheduling of the work to make a fair distribution of replicate tests through each day of testing to obviate the influence of time of testing on test results.

The principal source of discrepancy in the test results is traceable to the manner in which the ribbon is inserted in the clamps. A ribbon of 1/4-inch width is recommended because more consistent and accurate results may be obtained by employing a uniform width ribbon of this size. In tightening the clamps to hold the ribbon, care should be exercised to exert no more pressure on the ribbon than is required to hold it securely and permit all fibers to break smoothly during the testing operations. When these and other obvious precautions are exercised by an experienced operator, consistent results should be obtained, as shown in Appendix table 10.

The data made available through the tests here reported were sufficiently comparable to those obtained in the tests of the Washington operator and the designer of the tester to warrant continued use of the 1941 conversion formula for converting Pressley indexes to estimated Chandler strengths in thousands of pounds per square inch of material. The 1941 conversion formula is based on data obtained from tests made by a technologist of the Washington Cotton Testing Laboratory on 48 samples selected from the 1935-37 regional variety test cottons to represent a wide range in fiber strengths. The conversion formula derived from the test data of the designer of the tester represented the same 24 cottons as those employed in the tests at Stoneville. The three regression lines are shown in figure 1. The formula based on the Stoneville tests gives a slightly but not appreciably higher Chandler strength than those based on tests of either the Washington operator or the designer of the machine. This difference is traceable primarily to the unusually low strength figures obtained with machine A by all Stoneville operators, and to some extent to the fact that Stoneville operators B and C showed lower indexes than the other operators (tables 2 to 6, and fig. 2). In planning laboratory tests, it is therefore desirable to have two operators test each sample by making five breaks each and then to average the results of the ten breaks so made. This procedure has been found to provide significant and dependable results in the testing laboratories, especially since periodic check tests are made of operators as well as of machines.

## SUMMARY AND CONCLUSIONS

A newly developed cotton fiber strength testing machine, known as the Pressley Cotton Fiber Strength Tester, has been found to provide results which are highly correlated with those obtained by the well-known Chandler round-bundle method of determining tensile strength of cotton fibers. The tests on the new machine can be made about 6 to 8 times as rapidly as with the Chandler method, and therefore its adoption is rapidly taking place in various cotton fiber testing laboratories.

In order to provide information on the accuracy and consistency of the results obtained with the Pressley machine, a series of studies were made at the Department's Stoneville Laboratory in 1942, involving tests with 8 machines by 4 operators on 24 varieties of cotton, varying widely in fiber strength as previously determined by the Chandler method. Since earlier studies indicated the need for making 10 Pressley tests per sample to obtain results comparable in accuracy to those obtained by 10 tests with the Chandler method, 10 strength tests or ribbon breaks were made by each operator in the Stoneville tests.

The results indicated that there was a significant difference between means for operators and machines, and observations made during the tests revealed certain precautions for holding these differences down. The average Pressley strength index ranged from 7.24 to 7.58 for the different operators, or a difference on the Chandler strength basis of 3,000 pounds per square inch. Seven of the eight machines showed a range in strength similar to that found for the different operators. Only one machine gave exceptionally low average strength index, and this condition was traceable to the difficulties experienced in obtaining clean breaks of the fiber ribbon.

Some of the difference between machines and operators was attributable to the differences in results obtained during morning and afternoon testing. This was also found to be true by the designer of the tester who has made similar observations. So far, the discrepancies between morning and afternoon test results have not been explained. Another apparent source of discrepancy in test results is associated with the manner in which the ribbon is inserted in the clamps. The uniform employment of a ribbon of 1/4 inch in width was found to give more consistent and accurate test results than the employment of ribbons of other widths. In tightening the clamps holding the ribbon, it was evident that no more pressure should be exerted on the ribbon than that required to hold it securely and permit all fibers to break smoothly and evenly during the testing operations.

The test observations and results finally indicated that the test technique being employed in the Department's testing laboratories, with some modifications, should continue to provide significant test results. In this connection, it is desirable for two operators to test each sample, making five breaks each to provide data for averaging. Periodic check tests on a check sample are essential for consistent test results.

## APPENDIX

### Miscellaneous Basic Tables

The randomized order in which the samples were broken are shown in detail in table 8. This randomization is so laid out that each operator made 10 breaks on one cotton, then shifted to another machine to make his breaks on another cotton until breaks had been made on each of the cottons on all machines.

The effect of ribbon width on breaking strength is shown in table 9 for ribbon widths of 1/8-, 1/4-, and 3/8-inch, as well as for two clamps.

The results of periodic checks on the Pressley index are shown in table 10 for the four operators.

Table 8. - Randomized order in which the samples were broken

| Operator A | | | | | | | | Operator B | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Machine | | | | | | | | Machine | | | | | | | |
| A | B | C | D | E | F | G | H | C | D | E | F | G | H | A | B |
| 1 | 4 | 7 | 10 | 13 | 16 | 19 | 22 | 16 | 13 | 10 | 7 | 4 | 1 | 22 | 19 |
| 2 | 5 | 8 | 11 | 14 | 17 | 20 | 23 | 17 | 14 | 11 | 8 | 5 | 2 | 23 | 20 |
| 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 18 | 15 | 12 | 9 | 6 | 3 | 24 | 21 |
| 4 | 1 | 10 | 7 | 16 | 13 | 22 | 19 | 13 | 16 | 7 | 10 | 1 | 4 | 19 | 22 |
| 5 | 2 | 11 | 8 | 17 | 14 | 23 | 20 | 14 | 17 | 8 | 11 | 2 | 5 | 20 | 23 |
| 6 | 3 | 12 | 9 | 18 | 15 | 24 | 21 | 15 | 18 | 9 | 12 | 3 | 6 | 21 | 24 |
| 7 | 10 | 1 | 4 | 19 | 22 | 13 | 16 | 22 | 19 | 4 | 1 | 10 | 7 | 16 | 13 |
| 8 | 11 | 2 | 5 | 20 | 23 | 14 | 17 | 23 | 20 | 5 | 2 | 11 | 8 | 17 | 14 |
| 9 | 12 | 3 | 6 | 21 | 24 | 15 | 18 | 24 | 21 | 6 | 3 | 12 | 9 | 18 | 15 |
| 10 | 7 | 4 | 1 | 22 | 19 | 16 | 13 | 19 | 22 | 1 | 4 | 7 | 10 | 13 | 16 |
| 11 | 8 | 5 | 2 | 23 | 20 | 17 | 14 | 20 | 23 | 2 | 5 | 8 | 11 | 14 | 17 |
| 12 | 9 | 6 | 3 | 24 | 21 | 18 | 15 | 21 | 24 | 3 | 6 | 9 | 12 | 15 | 18 |
| 13 | 16 | 19 | 22 | 1 | 4 | 7 | 10 | 4 | 1 | 22 | 19 | 16 | 13 | 10 | 7 |
| 14 | 17 | 20 | 23 | 2 | 5 | 8 | 11 | 5 | 2 | 23 | 20 | 17 | 14 | 11 | 8 |
| 15 | 18 | 21 | 24 | 3 | 6 | 9 | 12 | 6 | 3 | 24 | 21 | 18 | 15 | 12 | 9 |
| 16 | 13 | 22 | 19 | 4 | 1 | 10 | 7 | 1 | 4 | 19 | 22 | 13 | 16 | 7 | 10 |
| 17 | 14 | 23 | 20 | 5 | 2 | 11 | 8 | 2 | 5 | 20 | 23 | 14 | 17 | 8 | 11 |
| 18 | 15 | 24 | 21 | 6 | 3 | 12 | 9 | 3 | 6 | 21 | 24 | 15 | 18 | 9 | 12 |
| 19 | 22 | 13 | 16 | 7 | 10 | 1 | 4 | 10 | 7 | 16 | 13 | 22 | 19 | 4 | 1 |
| 20 | 23 | 14 | 17 | 8 | 11 | 2 | 5 | 11 | 8 | 17 | 14 | 23 | 20 | 5 | 2 |
| 21 | 24 | 15 | 18 | 9 | 12 | 3 | 6 | 12 | 9 | 18 | 15 | 24 | 21 | 6 | 3 |
| 22 | 19 | 16 | 13 | 10 | 7 | 4 | 1 | 7 | 10 | 13 | 16 | 19 | 22 | 1 | 4 |
| 23 | 20 | 17 | 14 | 11 | 8 | 5 | 2 | 8 | 11 | 14 | 17 | 20 | 23 | 2 | 5 |
| 24 | 21 | 18 | 15 | 12 | 9 | 6 | 3 | 9 | 12 | 15 | 18 | 21 | 24 | 3 | 6 |

1/ Numbers in table refer to cotton sample numbers.

(left to right, top to bottom) 1/

| Operator C | | | | | | | | Operator D | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Machine | | | | | | | | Machine | | | | | | | |
| E | F | G | H | A | B | C | D | G | H | A | B | C | D | E | F |
| 7 | 10 | 1 | 4 | 19 | 22 | 13 | 16 | 7 | 10 | 13 | 16 | 19 | 22 | 1 | 4 |
| 8 | 11 | 2 | 5 | 20 | 23 | 14 | 17 | 8 | 11 | 14 | 17 | 20 | 23 | 2 | 5 |
| 9 | 12 | 3 | 6 | 21 | 24 | 15 | 18 | 9 | 12 | 15 | 18 | 21 | 24 | 3 | 6 |
| 10 | 7 | 4 | 1 | 22 | 19 | 16 | 13 | 10 | 7 | 16 | 13 | 22 | 19 | 4 | 1 |
| 11 | 8 | 5 | 2 | 23 | 20 | 17 | 14 | 11 | 8 | 17 | 14 | 23 | 20 | 5 | 2 |
| 12 | 9 | 6 | 3 | 24 | 21 | 18 | 15 | 12 | 9 | 18 | 15 | 24 | 21 | 6 | 3 |
| 1 | 4 | 7 | 10 | 13 | 16 | 19 | 22 | 1 | 4 | 19 | 22 | 13 | 16 | 7 | 10 |
| 2 | 5 | 8 | 11 | 14 | 17 | 20 | 23 | 2 | 5 | 20 | 23 | 14 | 17 | 8 | 11 |
| 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 3 | 6 | 21 | 24 | 15 | 18 | 9 | 12 |
| 4 | 1 | 10 | 7 | 16 | 13 | 22 | 19 | 4 | 1 | 22 | 19 | 16 | 13 | 10 | 7 |
| 5 | 2 | 11 | 8 | 17 | 14 | 23 | 20 | 5 | 2 | 23 | 20 | 17 | 14 | 11 | 8 |
| 6 | 3 | 12 | 9 | 18 | 15 | 24 | 21 | 6 | 3 | 24 | 21 | 18 | 15 | 12 | 9 |
| 19 | 22 | 13 | 16 | 7 | 10 | 1 | 4 | 19 | 22 | 1 | 4 | 7 | 10 | 13 | 16 |
| 20 | 23 | 14 | 17 | 8 | 11 | 2 | 5 | 20 | 23 | 2 | 5 | 8 | 11 | 14 | 17 |
| 21 | 24 | 15 | 18 | 9 | 12 | 3 | 6 | 21 | 24 | 3 | 6 | 9 | 12 | 15 | 18 |
| 22 | 19 | 16 | 13 | 10 | 7 | 4 | 1 | 22 | 19 | 4 | 1 | 10 | 7 | 16 | 13 |
| 23 | 20 | 17 | 14 | 11 | 8 | 5 | 2 | 23 | 20 | 5 | 2 | 11 | 8 | 17 | 14 |
| 24 | 21 | 18 | 15 | 12 | 9 | 6 | 3 | 24 | 21 | 6 | 3 | 12 | 9 | 18 | 15 |
| 13 | 16 | 19 | 22 | 1 | 4 | 7 | 10 | 13 | 16 | 7 | 10 | 1 | 4 | 19 | 22 |
| 14 | 17 | 20 | 23 | 2 | 5 | 8 | 11 | 14 | 17 | 8 | 11 | 2 | 5 | 20 | 23 |
| 15 | 18 | 21 | 24 | 3 | 6 | 9 | 12 | 15 | 18 | 9 | 12 | 3 | 6 | 21 | 24 |
| 16 | 13 | 22 | 19 | 4 | 1 | 10 | 7 | 16 | 13 | 10 | 7 | 4 | 1 | 22 | 19 |
| 17 | 14 | 23 | 20 | 5 | 2 | 11 | 8 | 17 | 14 | 11 | 8 | 5 | 2 | 23 | 20 |
| 18 | 15 | 24 | 21 | 6 | 3 | 12 | 9 | 18 | 15 | 12 | 9 | 6 | 3 | 24 | 21 |

Table 9. - Effect of variations in ribbon width of the check sample on strength index with two sets of clamps on machine C 1/

| Ribbon width | | Clamp 33 | Clamp 50 | All clamps |
|---|---|---|---|---|
| | | Index | Index | Index |
| 1/8" | Average | 7.91 | 8.36 | 8.14 |
| | Range | 7.37-8.52 | 7.76-8.82 | 7.37-8.82 |
| 1/4" | Average | 7.60 | 7.84 | 7.72 |
| | Range | 7.00-8.15 | 7.32-8.39 | 7.00-8.39 |
| 3/8" | Average | 6.89 | 7.11 | 7.00 |
| | Range | 6.45-7.54 | 6.77-7.54 | 6.45-7.54 |

1/ Data represent average of five tests or ribbon breaks by each of two operators.

Table 10. - Pressley indexes 1/ for check sample tested periodically by each operator on machine C during the study

| Date and time | Operator | | | | Average |
|---|---|---|---|---|---|
| | A | B | C | D | |
| | Index | Index | Index | Index | Index |
| 7-21-42 p.m. | 7.79 | 7.93 | 7.93 | 8.11 | 7.94 |
| 7-22-42 p.m. | 8.00 | 8.06 | 7.76 | 7.69 | 7.88 |
| 7-28-42 p.m. | 7.96 | 7.41 | 7.28 | 7.85 | 7.62 |
| 7-29-42 p.m. | 8.02 | 7.46 | 7.45 | 7.59 | 7.63 |
| 8-3-42 p.m. | 7.86 | 7.85 | 7.71 | 7.94 | 7.84 |
| 8-10-42 p.m. | 7.41 | 7.31 | 7.39 | 7.55 | 7.42 |
| Average | 7.84 | 7.67 | 7.59 | 7.79 | 7.72 |

1/ Average of five tests or ribbon breaks.

Figure 1. - Relationship of Pressley strength index to Chandler strength in pounds per square inch for designer of Pressley tester, Washington operator, and all Stoneville operators

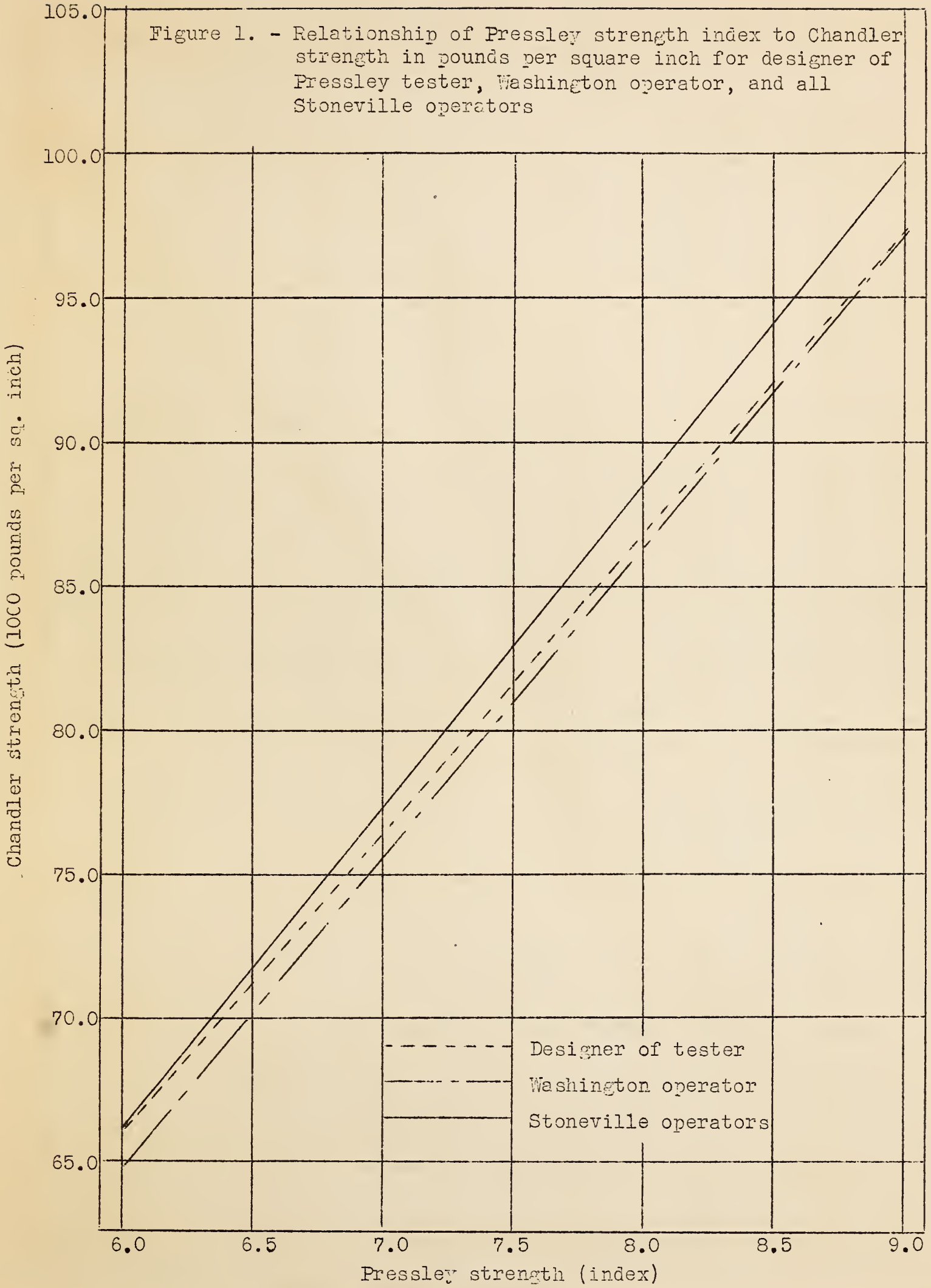

Figure 2. - Relationship of Pressley strength index to Chandler strength in pounds per square inch for four operators in tests on eight Pressley testers